

Commonwealth of Virginia
Harmful Algal Bloom Response Plan
July 2017

The Virginia Harmful Algal Bloom Task Force Response Plan outlines the roles, responsibilities, and response obligations of primary support members, which include public notification, during a harmful algal bloom (HAB) event.

Health advisory thresholds, public notification templates, sampling protocols, and related guidance, including primary support member annual operational plans are available on the HAB Task Force website: www.HarmfulAlgaeVa.com.

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INTRODUCTION

Phytoplankton are microscopic algae that are commonly found in freshwater and marine habitats. They represent a major source of food and oxygen for many of the inhabitants present in lakes, rivers, estuaries, and oceans. Among the several thousand species of phytoplankton that exist worldwide, approximately 70 to 80 of these are known toxin producers. These toxins are potentially harmful to humans and pets, as well as to birds, fish, and other organisms.

Usually, algae are absent or present in low concentrations that pose no environmental or human health threat. However, with certain environmental conditions, algae may proliferate to form dense concentrations of cells that potentially cause detrimental impacts through toxin production or other mechanisms. These are referred to as harmful algal blooms or HABs. HABs have been documented in the coastal waters of both the eastern and western United States, as well as other coastal areas throughout the world. Algal blooms formed by algae which are not known to produce toxins are also common seasonally, and may be observed as discolored water (green, red, brown, etc.), but do not pose animal or human health concerns. In Virginia, HABs may occur throughout the year, with the majority occurring from early spring through the fall months. To date there are at least 38 potential toxin producing species that have been recorded in Virginia waters and the lower Chesapeake Bay, with the possibility of other toxic species becoming established (Marshall et al. 2008, Marshall and Egerton 2012).

Human exposure to HAB toxins may occur by three modes of transmission; consumption, absorption through the skin, or by respiration of aerosolized toxin. Consumption is the most concerning mode for public health due to the effect which toxins may have on internal organs and the potential to result in a fatality. Consumption may include direct ingestion of certain fish/shellfish that have accumulated toxins, accidental ingestion while swimming in a bloom, or from a drinking water source contaminated with algal toxins. In general, children and pets are more vulnerable to HAB toxins as a result of their small size (i.e. a small amount of ingested toxin may cause illness). Exposure due to the consumption of affected fish/shellfish is a commonly reported exposure mode, and such, is a primary concern given the ability to transport fish and shellfish from an affected area to consumers nationwide. Although shellfish and finfish may become toxic and cause human illness in the absence of a visible bloom, illness is usually associated with the presence of a visible bloom. The most widely recognized

human illnesses/toxins caused by HABs are:

- Amnesic shellfish poisoning (ASP)
- Ciguatera fish poisoning (CFP)
- Diarrhetic shellfish poisoning (DSP)
- Neurotoxic shellfish poisoning (NSP)
- Paralytic shellfish poisoning (PSP)
- Microcystin (freshwater cyanobacteria toxin)

Amnesic, Ciguatera, Diarrhetic, Neurotoxic, and Paralytic fish/shellfish syndromes are affiliated with marine and brackish water HAB species producing toxins that accumulate within the edible tissues of the organism, causing illness when consumed. Microcystin is a freshwater and brackish-water toxin produced by several cyanobacteria (blue-green algae) species, but its ability to accumulate in edible tissues above guidance levels has not been well established. For a more comprehensive list of HAB syndromes and their symptoms, please see visit the HAB Task Force website.

HABs appear to be increasing in frequency, distribution and magnitude both regionally in the Chesapeake Bay, and worldwide (Anderson et al. 2012, O'Neil et al. 2012, Marshall and Egerton 2012). The reason for the increase is likely due to many factors including climatic changes, anomalous weather events, transport of nonindigenous marine species through the ballast water of ships, and nutrient pollution of marine and fresh waters. Innovative surveillance methods and analytical techniques, as well as increased monitoring for HAB species and toxins, may also contribute to their perceived increase.

Nationally, significant cyanobacterial HAB events over the last decade have resulted in negative impacts upon fresh drinking water sources, recreational areas, human health and aquatic life. Virginia has not experienced significant impacts as a result of freshwater blooms to date. The Virginia HAB Task Force coordinates activities of state agencies and institutions involved in routine seasonal surveillance of public fresh waterbodies to evaluate the presence and prevalence of HAB species and associated toxins in drinking water sources and recreational areas.

The Virginia HAB response plan has four priority objectives:

- 1) Summarize the methods of surveillance for and identification of HAB species in marine and fresh waterbodies.
- 2) Define the process for responding to and managing HAB events.
- 3) Identify government agencies authorized and responsible to provide a response and assistance during HAB events. And;
- 4) Provide public notification processes and procedures which may be utilized to alert officials and the public of HAB activity in order to protect the health and well-being of humans and animals.

VIRGINIA HAB TASK FORCE

Virginia's response to potential HAB events began in the late 1990's with a focus on dinoflagellates of the *Pfiesteria* complex. This included conducting a human health survey, and responding to fish kills and observations of fish with lesions. These activities were coordinated by the Virginia *Pfiesteria* Task Force, now known as the Virginia HAB Task Force. In the approximately 20 years since its inception, the Task Force has expanded to include all HAB species and events that are relevant within the state. This has included coastal and marine HAB species associated with fish kills and potential shellfish biotoxins. More recently, this has included freshwater species associated with drinking and recreational concerns in Virginia's reservoirs, lakes, and rivers. The Task Force continues to facilitate coordination of the Commonwealth's response to HAB events, sharing and disseminating information, and coordinating resources.

VIRGINIA HAB TASK FORCE MEMBERS

The Task Force is comprised of members from multiple agencies and institutions. Primary support members have immediate and direct roles during HAB events in addition to the coordination of surveillance and response activities. These members include the Virginia Department of Environmental Quality (VDEQ), Virginia Department of Health (VDH), Virginia Institute of Marine Science (VIMS), Old Dominion University (ODU), and the Virginia Marine Resources Commission (VMRC). Roles and responsibilities of primary support members are detailed in the following sections. The Virginia HAB Task Force Charter (2017) formally establishes the obligations of Primary Support Task Force Member

Agencies and provides infrastructure for the group. There are also a number of agencies and academic institutions that may share a direct or indirect role during Task Force response efforts, known as secondary support members. A list of secondary support members is available on the Task Force website.

MONITORING AND RESPONSE TO HABs

Objective 1: Surveillance and Identification of HAB species

Accurate assessment of HABs and associated impacts on Virginia's natural resources requires a monitoring program for algal species and their impacts through an integrated plan for rapid and effective response to events. There is a continued need to understand the environmental influences (biotic and abiotic) associated with bloom initiation, as well as transport and subsidence of HAB species in Virginia estuaries and free-flowing waters and lakes. Local algal blooms can be impacted by both nutrient additions as well as weather (temperature, precipitation, wind, etc.) patterns. Concurrent collection of environmental data along with bloom sampling is integral to the response and monitoring plan.

Brackish and Marine Waters

Virginia has developed and implemented a multi-agency effort for monitoring and research on brackish and marine HAB organisms. This effort includes extensive participation by ODU and the VIMS, both of which have been active participants in Virginia's Chesapeake Bay Monitoring Program (CBMP). Phytoplankton identification and enumeration of all taxa, including HAB species is conducted by ODU as part of the VDEQ/CBMP phytoplankton monitoring program. This includes routine analyses of fixed stations throughout lower Chesapeake Bay and Virginia tidal tributaries that are collected by ODU and VDEQ. Representative stations within shellfish growing areas throughout the state are sampled by VDH Division of Shellfish Sanitation and analyzed for HABs. Research at the VIMS includes both visual and molecular enumeration of bloom taxa, as well as bioassays assessing aquatic animal health effects and biotoxin characterization.

Freshwater

A number of sites are selected for freshwater surveillance each year to evaluate the presence and concentration of HAB species. VDEQ's extensive network of state-wide water quality monitoring

stations also provide ongoing passive freshwater bloom surveillance.

Objective 2: Responding to and Managing HAB Events

The Task Force prioritizes efforts for the detection of HAB species and toxins in waters supporting shellfish growing areas, drinking water sources, and public recreational uses.

Outside of routine monitoring, response driven collections and analyses are conducted by the primary support member agencies, as needed. Typically, fish kills and citizen algae bloom complaints will be directed to VDEQ for investigation, with VDH providing assistance and coordination with health professionals for response to health complaints, and analysis of samples provided by ODU and VIMS.

A seven-day per week, 24 hour per-day HAB response capability is a joint effort between VMRC, VDH and VDEQ, with laboratory support by VIMS and ODU, facilitated by reporting through the HAB Hotline and online HAB report form. A contact list of HAB Task Force Members is updated frequently to facilitate efficient communication of the primary and secondary support members.

During HAB events that present a human or animal health risk, under their respective authority, primary support members will follow protocols defined by membership roles. Further, members will rely on the most current advisory guidance thresholds for issuing and lifting advisories for the given HAB species and/or toxin(s).

Privately owned waterbodies (man-made ponds and lakes) in either commercial or residential communities as well as stormwater basins may experience algae blooms or HABs. Stormwater basins are vulnerable to algal blooms because their purpose is to collect and retain sediments, nutrients, and other pollutants in order to protect waterways. Outreach and education regarding HABs may be provided to owners of privately owned waterbodies or stormwater treatment owners, however the Task Force efforts and resources will not be prioritized unless there is a potential risk to public waters. The Task Force will use discretion with resources for providing surveillance and response by collaborating with primary support members and local officials to ensure the protection of public health. Recommendations for preventing algal blooms and other resources for owners of private waterbodies or stormwater treatment works are provided on the Task Force website.

Objective 3: Identify Primary Support Members and their Roles & Responsibilities

Primary support member sampling protocols and operational plans can be found on the Task Force website.

Virginia Department of Environmental Quality (VDEQ)

VDEQ serves with VDH as a co-lead for coordinating Task Force activities. VDEQ's responds to suspected HAB events and fish kills that may be the result of a HAB. DEQ collects HAB samples which are analyzed by ODU and VIMS and provides data on water quality conditions associated with blooms. HAB responses can occur during DEQ's routine monitoring if a bloom is detected but more often DEQ investigates blooms via reports from others (watermen, citizens, etc.).

VDEQ develops an annual operational plan for VDEQ staff for conducting response to suspected HABs and fish kills. All suspected HABs or fish kills are referred to an initial HAB responder. If a name and number is available, the first step is to call the person who reported the fish kill or algae bloom to get first-hand information. Once the responder has determined that the event should be investigated as a possible HAB event, the responder gathers response equipment and proceeds to the site.

The initial HAB responder will always take a complete package of HAB response equipment and supplies. This package of equipment and supplies will be staged and ready to go. If a site investigation confirms a possible HAB event, the responder will contact VIMS and ODU to provide notification of the event and arrange for sample delivery. The responder will also contact other HAB Task Force primary support members and VDEQ management for initiation of the HAB communication protocol. Next, the responder will determine the extent of the bloom or fish kill and take appropriate samples for verification of the presence of HABs and coordinate transfer of samples to the laboratory for analysis.

If the responder or VDEQ management feels it necessary, a follow-up response will be conducted. The follow-up response crew will deliver samples to the appropriate agencies. Every effort should be made to perform a follow-up response the next morning. The follow-up response will be for the collection of HAB organism samples, chlorophyll, water quality samples.

Virginia Department of Health (VDH)

VDH serves with VDEQ as a co-lead for coordinating Task Force activities and includes primary support members from three VDH offices, each with specific roles and responsibilities to Task Force operations. These offices are responsible for developing guidance for issuing human health advisories

for HABs in recreational waters, managing shellfish growing area closures, and coordinating with water treatment operators in source waters where HABs are detected at elevated levels.

Office of Environmental Health Services - Division of Shellfish Sanitation (DSS)

VDH:DSS is responsible for the routine collection of water and/or sediment samples from shellfish growing areas, as well as bloom response sampling including shellfish collections if necessary. DSS conducts and/or coordinates analyses of phytoplankton and biotoxins, and may establish shellfish harvest restrictions, utilizing the methods and criteria as described by their marine biotoxin contingency plan and the National Shellfish Sanitation Program Manual of Operations.

Approximately sixty fixed stations within shellfish growing areas are sampled by DSS monthly from March through October. Additional bloom samples are collected as necessary when and where discolored water or fishkills are observed throughout the year. Surface (~0.5m) lugol's preserved samples (500ml) destined for phytoplankton species analysis are collected, along with non-preserved samples for potential toxin screening (ELISA, LC-MS/MS, etc.). Field parameters include station location, date, water temperature; salinity; dissolved oxygen and secchi depth are taken for each collection and recorded on the sample bottle.

Phytoplankton samples are delivered to DSS Norfolk Field Office or to the Phytoplankton Analysis Laboratory at ODU. Non-preserved samples must be kept on ice and delivered to the lab within 24hrs. Samples (fresh, frozen or filtered) for toxin analyses associated with potential shellfish biotoxin events are to be delivered to VIMS Department of Aquatic Health Sciences for toxin analyses.

Office of Epidemiology - Division of Environmental Epidemiology (DEE)

HUMAN DISEASE SURVEILLANCE FOR HEALTH EFFECTS FROM HABs

Health Effect Considerations

Health concerns center on direct exposure to HAB toxins in water related activities or professions, and illnesses associated with eating contaminated shellfish or fish. If it were determined that health effects result from exposure to these events, then appropriate investigations would consider the following:

1. What are the health effects?
2. How are they manifested?

3. What is the pathogenesis?
4. What are the risk factors for developing health effects?
5. How can exposure or health effects be prevented?
6. How can health effects be treated?
7. How can exposure be measured?
8. How can illness be definitively diagnosed?
9. Is there a dose response?
10. Which HABs are responsible?

HUMAN DISEASE SURVEILLANCE - Passive Surveillance

Increasing Awareness

The Division of Environmental Epidemiology (VDH:DEE) will develop information on health effects from HABs and distribute it to medical care providers and local health departments via the Virginia Epidemiology Bulletin, the VDH website, and other venues (e.g. social media, meetings, conference calls). DEE will make information on HABs available to the public via brochures and the Task Force website.

Reporting

Physicians will be urged to report suspected HAB health effects to their local health departments who will in turn notify DEE.

The HAB Hotline (888-238-6154) will be monitored for reports of suspected HAB related illness from the public. Blooms reported to the hotline will be entered in the online HAB report form accessed on the Task Force website.

The online HAB report form provides a mechanism for citizens to report suspected bloom and fish kill events, serves as a database for bloom complaint information, instantly notifies primary response staff of a complaint, and automatically emails the submitter with an email containing links to HAB information.

Documenting Human and Animal Exposures

Local health departments and DEE may utilize a HAB initial health screening form for evaluating suspected HAB exposure cases. DEE and local health departments will provide guidance to physicians on diagnostic testing and case management. When appropriate, human and animal

surveillance reports supplied by the Centers for Disease Control and Prevention (CDC) will be completed by the local health departments and DEE will review the data for indications of increased risk. Completed screening forms will be documented at DEE and CDC surveillance reports will be documented within the CDC's One Health Harmful Algal Bloom System (OHHABS).

HUMAN DISEASE SURVEILLANCE - Active Surveillance and Outbreak Investigation

Triggers for initiating active surveillance:

- Confirmed HAB due to an organism known or suspected to cause human illness
- Cluster of human or other mammal illnesses associated with a recent HAB.

Active surveillance activities: *conducted by local health district, regional and/or central office epidemiologists, and/or other staff*

- Review records in local hospitals and medical practices
- Utilize media to notify public to report cases, if necessary
- Develop line list of potential cases, establish database with demographic, exposure and clinical information
- Summarize and analyze data

Outbreak investigations:

Investigations will be conducted by the local health district, regional and central office epidemiologists and other staff in accordance with standard epidemiologic methods for data collection, analyses, report writing, summary findings, and recommendations.

Reports and Confidentiality

Summary reports of surveillance and outbreak investigations will be provided to all interested parties. Patient confidentiality will be protected and no personal identifying information will be released.

Public Recreational Waters - Surveillance and Response for HABs

VDH:DEE will post results of response samples on the Algal Bloom Map located on HAB Task Force website.

Freshwater

Freshwater surveillance of publicly accessible lakes and other bodies of water has been

conducted annually by VDH:DEE since 2010, with analytical and technical services provided by ODU. Data collected at targeted freshwater surveillance sites include water chemistry, species identification for potentially harmful species present, and if necessary, toxin analysis.

DEE will support and facilitate freshwater HAB investigations in coordination with Task Force partners and will provide the local health district (or state/federal owner of the waterbody) with recommendations based on HAB investigation results. Districts have the discretion and responsibility of issuing and lifting local recreational advisories, with support and guidance supplied by DEE. The HAB Task Force website contains the current recreational advisory guidance thresholds for freshwater species and the toxins they may produce, in addition to recommendations on monitoring frequencies when HABs may be present.

Marine water

Approximately 50 public coastal beach sites are monitored weekly from May – September by the VDH Coastal Beach Monitoring and Notification Program. If HAB species are present at concentrations which could pose a potential human health risk near beaches, sampling may be facilitated by district beach monitoring staff.

Office of Drinking Water (ODW)

The Office of Drinking Water (ODW) regulates waterworks with surface water intakes supplying drinking water to approximately 76% of Virginia residents. VDH:ODW may be informed of a potential HAB in multiple ways, such as:

- A HAB Taskforce member notifies the ODW.
- The waterworks owner or operator notifies the ODW of a bloom seen near intake or taste and odor problems detected.
- A taste and odor complaint consistent with an algae bloom is received by the ODW.

The ODW will coordinate with the waterworks to confirm that an algae bloom is impacting the drinking water supply, and to determine if that algae bloom is harmful in nature. If the ODW determines that there is sufficient evidence to suggest that a potential HAB may impact a waterworks, the ODW will inform the HAB Taskforce and issue an Event Notification to inform VDH senior leadership. The ODW will then coordinate the emergency response with the waterworks and the Virginia Department of Emergency

Management (VDEM). The ODW will provide technical assistance to the waterworks, and public education information to waterworks and their customers, as needed.

Old Dominion University (ODU)

Old Dominion University (ODU) is responsible for the phytoplankton species composition analyses, including enumeration of all potentially toxic taxa, from routine water samples collected by VDH:DSS and additional bloom collections by VDEQ and other HAB Task Force members. Molecular and electron microscopic analyses will also be conducted as needed. All HAB events relating to shellfish growing areas will be coordinated with VDH:DSS in a timely manner to inform shellfish management decisions. ODU is also responsible for the phytoplankton analyses and toxin screening (ELISA) of freshwater blooms sampled by VDEQ, VDH:DEE and other VA HAB Task Force members.

Virginia Institute for Marine Science (VIMS)

VIMS is responsible for identification and enumeration of HAB species using microscopic and molecular genetic methods on samples collected for monitoring by VIMS personnel, and those collected in response to blooms and fish or shellfish kills by VIMS and other HAB Task Force. VIMS utilizes bioassays to assess impacts of HAB species on aquatic animal health. VIMS also conducts biotoxin analyses by ELISA and/or LC-MS/MS in response to blooms, and fish or shellfish kills, as needed. VIMS is responsible for pathological analyses of finfish with lesions, and animals from fish and shellfish kill events.

Virginia Marine Resources Commission (VMRC)

The VMRC is a member of the Virginia HAB task force and serves multiple roles in the response plan. If the DEQ is not able to access a boat necessary for the evaluation of suspected HAB events and fish kills, the VMRC Law Enforcement Division will provide a vessel for the evaluation. If requested by the VDH, the VMRC will post announcements of HAB events or fish kills that are of public concern but do not impact human health. If a HAB or fish kill event requires the closure of a waterway within the jurisdiction of the VMRC, the agency will enforce that closure. The VMRC will also work with VDH to post signs alerting the public of HAB events and the risks of coming into contact with affected waters, as needed.

Objective 4: Notification During HAB Events

Monitoring data collected will be displayed on a web-based Algal Bloom Map and routinely updated during the HAB season (spring to fall). Event notifications, public notifications, and the issuance and lifting of advisories which limit public access to HAB waterbodies may be issued based on the most current guidance for HAB species and toxin thresholds. Signage used to warn the public of a HAB event are available in pdf on the Task Force website or may be obtained by contacting VDH:DEE.

HAB COMMUNICATION SEQUENCE

The following outline should be followed with all due speed. Depending on seriousness of event, conference calls or face-to-face meetings may be scheduled.

1. HAB complaints, depending on type, are referred for investigation to:
 - a. Health event: VDH
 - b. Fish kill or algal bloom: VDEQ
 - c. Shellfish mortalities or fish with lesions: VIMS
2. Rapidly distribute a summary of the HAB complaint to Primary Support members. This may be accomplished using the online HAB submittal form or email distribution list.
 - a. Include summary of knowledge to date and brief outline of plans for investigation.
 - b. Notify primary support members of any needs required to respond and to conduct investigation.
3. Rapidly initiate investigation. Samples may be collected for water quality conditions, phytoplankton analysis following protocols available on the Task Force website. Additional samples (i.e., for molecular, toxin, or fish and shellfish samples) will be determined during the investigation.
4. Rapidly report initial investigation summary to Primary Support members and local health district. Support of secondary members will be requested as needed.
 - a. Include samples taken, time of delivery to which laboratory and estimated time of test results.
 - b. Provide suggested plans for further investigation and/or control.
5. Rapidly report laboratory results to Primary Task Force members, the local health district, and

others as needed.

6. Distribute final report to all interested parties in a timely manner.

HARMFUL ALGAL BLOOM PUBLIC INFORMATION PROCEDURES

Notification of Public and Media

The Public Relations Coordinator (PRC) for the VDH Office of Epidemiology will be notified promptly of any HAB related events that may impact public health or cause public concern and will coordinate the development and distribution of public awareness messages with all agencies represented on the HAB Task Force. VDH will rely on the technical expertise of ODU and VIMS in preparing all such releases to the public and media.

VDH central office and local health departments will notify the public and regional media about an event, which can include a fish/shellfish kill, algal bloom, or other water-related condition that may involve HABs and have an impact upon public health or may cause significant public concern. The PRC will coordinate with VDH Regional Public Information Officers (PIOs) to develop media announcements outlining the location of the HAB and clearly defining any prevention messages, including possible consumption advisories and swimming restrictions, to protect public health. This information will be made available on the Task Force website.

In the event of a fish/shellfish kill, algal bloom or other HAB-related situation that does not impact human health, but may be the source of public concern, VDH will provide information to the public about the situation via media release and/or posting on the VDH website depending upon the significance of the event. Template media releases are available on Task Force website. Announcements of events not impacting human health will be coordinated with all agencies represented on the Task Force.

If a HAB related event requires the closure or issuance of a public advisory of a waterway to protect public health, the Commissioner of Health or an appropriately authorized entity will order the closure and involved state agencies and the media will be notified. VMRC or DGIF will enforce the closure on their respective waterways. VDH will supply signs, which will be clearly posted to alert the public of the risks associated with contact with the water in that area. DGIF, VMRC and/or VDH local health departments may coordinate to post the signs. Template advisory and closure signs are available in pdf on the Task Force website or signs may be obtained by contacting VDH:DEE.

VDH will develop informative flyers on HABs which will include directions for individuals who may have been exposed to HABs during an event. These materials will be distributed to local health departments and other agencies.

VDH will share all media alerts, printed materials and other public information messages with involved agencies and will collaborate on message development in the event of a HAB related event. Sample results of HAB investigations will be displayed on the Algal Bloom map updated routinely on the Task Force website.

References

- Anderson, D.M., Alpermann, T.J., Cembella, A.D., Collos, Y., Masseret, E. and Montresor, M., 2012. The globally distributed genus *Alexandrium*: multifaceted roles in marine ecosystems and impacts on human health. *Harmful algae*, 14, pp.10-35.
- Marshall, H. G., and Egerton, T. A. 2012. Bloom and toxin producing algae in Virginia tidal rivers. In *2012 Oceans* (pp. 1-5). IEEE.
- Marshall, H.G., L. Burchardt, T.A. Egerton, and M. Lane, 2008. "Status of potentially harmful algae in the Chesapeake Bay estuarine system, " in Proceedings of the 12th International Conference on Harmful Algae. International Society for the Study of Harmful Algae and Inter-governmental Oceanographic Commission, O Moestrup, et al. Eds. Copenhagen: UNESCO, 2008, pp. 203-205.
- O'neil, J.M., Davis, T.W., Burford, M.A. and Gobler, C.J., 2012. The rise of harmful cyanobacteria blooms: the potential roles of eutrophication and climate change. *Harmful Algae*, 14, pp.313-334.

Acronym List

ASP	Amnesic shellfish poisoning
CBMP	Chesapeake Bay Monitoring Program
CDC	Centers for Disease Control and Prevention
CFP	Ciguatera fish poisoning
DGIF	Department of Game and Inland Fisheries
DSP	Diarrhetic shellfish poisoning
ELISA	Enzyme-Linked Immunosorbent Assay
HAB	Harmful Algal Bloom
LC-MS/MS	Liquid Chromatography-(tandem)Mass Spectrometry
NSP	Neurotoxic shellfish poisoning
ODU	Old Dominion University
OHHABS	One Health Harmful Algal Bloom System
PIO	Public Information Officer
PRC	Public Relations Coordinator
PSP	Paralytic shellfish poisoning
VDEQ	Virginia Department of Environmental Quality
VDH	Virginia Department of Health
VDH:DEE	Division of Environmental Epidemiology (of the Office of Epidemiology)

VDH:DSS	Division of Shellfish Sanitation (of the Office of Environmental Health Services)
VDH:ODW	Office of Drinking Water
VDH:OEHS	Office of Environmental Health Services
VDH:OEPI	Office of Epidemiology
VIMS	Virginia Institute of Marine Science
VMRC	Virginia Marine Resources Commission